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Design of Solar Car Chassis

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ABSTRACT

The aim is to design, analyze and fabricate a roll cage for Electric Solar Vehicle. It deals with modeling of roll cage of SOLAR POWERED VEHICLE and analyzing it to give an optimum design. The main objective of this research work is to perform analysis (structural) on our frame considering the safety and ergonomics of driver during any collision or accident, to have a compact frame with less weight and with good asthetics as well. The structure model is prepared in SOLIDWORKS 2018 software and analysis is also done in SOLDWORKS.

KEYWORDS: *Solar car, chassis, design, analysis*

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INTRODUCTION

The aim was to design a vehicle that can contribute towards environmental stability and at the same time is easy to manufacture, stable and also cost effective. The design methodology involved recognition of customer's need and market survey that led to design of a vehicle with adequate safety and good ergonomics.

Design and Calculations:

- Frame design
- Material selection and Comparison
- Comparison of different material for Roll Cage
  1. Formula Used
  2. Frame Dimension
  3. Roll cage and Frame Analysis(FEA)

- **FORMULA USED :-**

$$\text{BENDING STRENGTH} = \frac{\text{YIELD STRENGTH X MOMENT OF INERTIA}}{\text{C}}$$

$$\text{BENDING STIFFNESS} = \text{Young's Modulus X MOMENT OF INERTIA}$$

$$\text{MOMENT OF INERTIA} = 3.14(R_o\hat{}4-RI\hat{}4)$$

1. Frame Dimension:

Configuration tadpole design specs are as below:
Length*width =2185mm*1474mm
Height =1397mm
Wheelbase=1524mm
Track width=1320mm
Frame weight=28kg

Table1: COMPARISON OF DIFFERENT MATERIALS FOR ROLL CAGE

MATERIAL	AISI1020	AISI4130	AA6063 T6	AA6061 T6	AISI 1018
DIMENSIONS	O.D:1inch Th:2mm	O.D:1INCH Th:1.25mm	O.D:1.5INCH Th:2mm	O.D:1.5INCH Th:2mm	O.D:1INCH Th:2mm
YIELD STRENGTH	351.57MPa	460MPa	251MPa	260MPa	370Mpa
DENSITY	7900kg/m^3	7850kg/m^3	2700kg/m^3	2700kg/m^3	7870kg/m^3
TENSILE STRESS	420.51MPa	731MPa	240MPa	300MPa	440Mpa
BENDING STIFFNESS	561.13N-m	734.19N-m	1425.25N-m	1455.25N-m	109.76N-m
BENDING STRESS	4155.35N/m^2	4155.35N/m^2	8702.07 N/m^2	8702.07 N/m^2	4155.35N/m^2
MOMENT OF INERTIA	2.027*10^{-8}m^4	2.027*10^{-8}m^4	1.263*10^{-7} m^4	1.263*10^{-7} m^4	2.027*10^{8}m^4

After analyzing and comparison we decide to go with the material AISI-4130.Because it has more strength than any other material.

2. Roll cage/Frame Analysis (FEA):-

After finalizing the frame along with its material and cross section. It is very important to test the chassis under several conditions.

Following test are performed on the roll cage:
- Front Impact
- Rear impact
- Side impact test
- Torsional test
- Roll over test

Table2: Comparison of different pipe dimensions for ROLLCAGE

Material	PIPE SIZE		Weight(kg)	CALCULATED FOS (force in Newton)			
	Outer Dia(in)	[illegible]		Front Impact	Side Impact	Torsional	Roll Over
AISI 4130	1	1.25	28	2.4(17362N)	1.2(2171N)	2.2(2170N)	2.1(4750N,1400N)
AISI 4130	1.25	1	33.5				
AISI 4130	1.25	1.5	37.46	4.8 (17362N)	1.6(2171N)	1.9(2170N)	1.5(4750N,1400N)
AISI 4130	1.5	1.5	38.4	2.7(17362N)	1.4(2171N)	1.5(2170N)	2.4(4750N,1400N)
AISI 1020	1	1.5	31.55	0.52(17362N)	0.6(2171N)	1.3(2170N)	0.86(4750N, 1400N)
AISI 1020	1.25	1.5	32	0.91(17362N)	0.58(2171N)	1.4(2170N)	1.3(4750N,1400N)
Al 6063-T6	1.5	3	28	1.4 (17362N)	0.49 (2171N)	2.5 (2170N)	1.9(4750N,1400N)
Al 6063-T6	2	3	34.38	2.5(17362N)	0.83(2171N)	2.5(2170N)	3.4(4750N,1400N)
Al 6061-T6	1.5	3	25	1.8(17362N)	0.62(2171N)	0.74(2170N)	2.5(4750N,1400N)
Al 6061-T6	2	3	30.46	0.85(17362N)	0.54(2171N)	1.4(2170N)	2.6(4750N,1400N)

We decided to opt AISI 4130 pipe of dimension 1in*1.25mm cause it is providing us the best FOS with less weight

1. FRONT IMPACT TEST:-

ASSUMPTIONS: -

M = 250Kg

VI= 13.88m/s VF= 0m/s Time= 0.2s

F= 7220/1.534= 4750N

NO. of Beams = 2

Force per beam = 4750/2= 2375

Momentum=Impact

250*13.88= F*0.2F= 17362N Number of nodes =6

Force/node=2900N (approx)

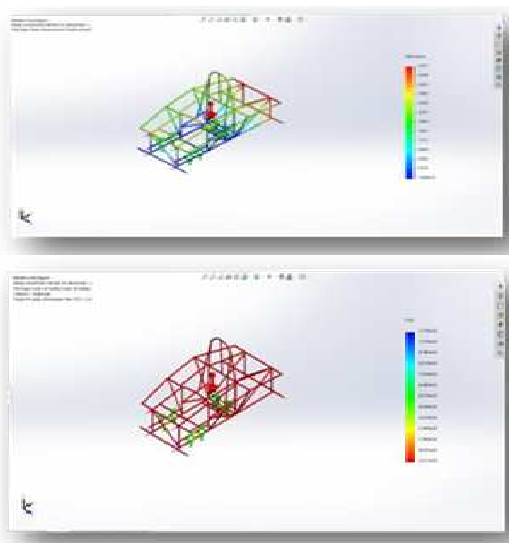


Fig 1: Stress analysis on front side.

Max. Stress = 189.9N/mm^2

Max. Displacement = 3.937 mm

FOS = 2.4

2. Rear Impact Test

F_f=F_{rear}=17362N

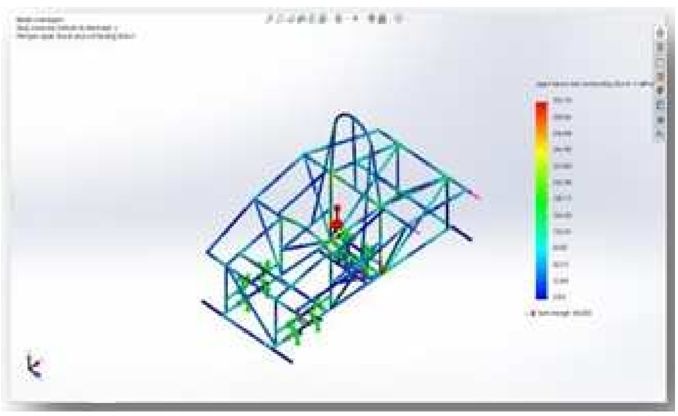
FOS=1.4

3. SIDE IMPACT TEST:-

F_{front}=17362N

F_{side}=F_{front}/2= 8681N

- No of Nodes=4
- Force/node=2171N



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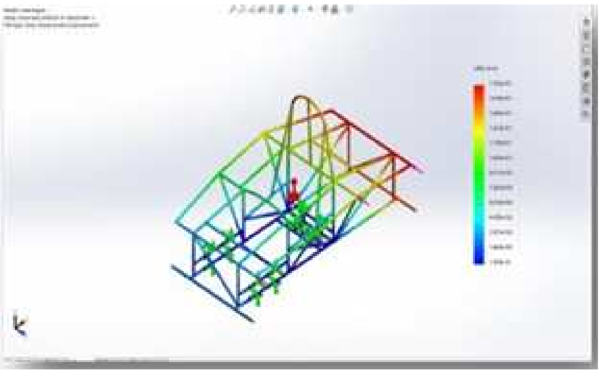

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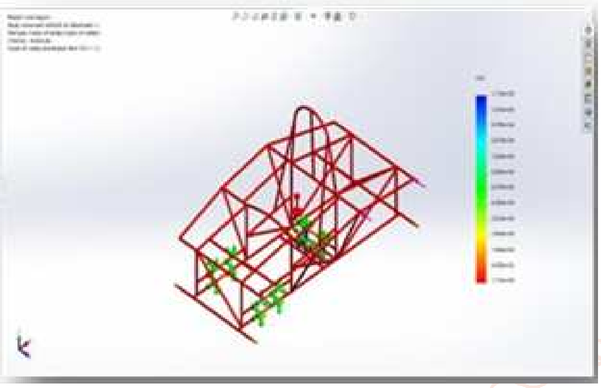


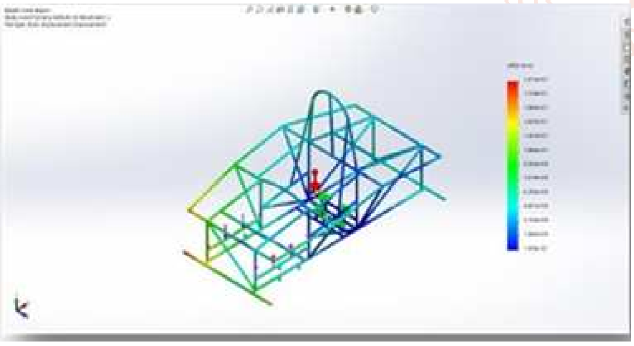
(c)

Fig2: a,b,c represents stress analysis on side.

Max. Stress = 392.26 N/mm^2
Max. Displacement = 1.762mm
FOS = 1.2

4. Torsional Analysis:-

F_{front}= 17362N
$F_{Torsion}$=F_{front}/4=4340.5
F/side=4340.5/2
=2170.25 N
No of nodes=4
Force/node= 542.56 N



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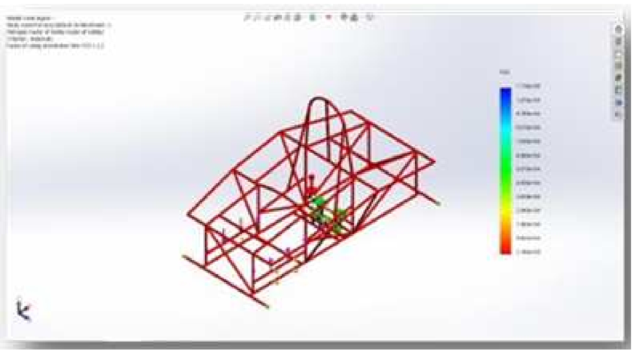
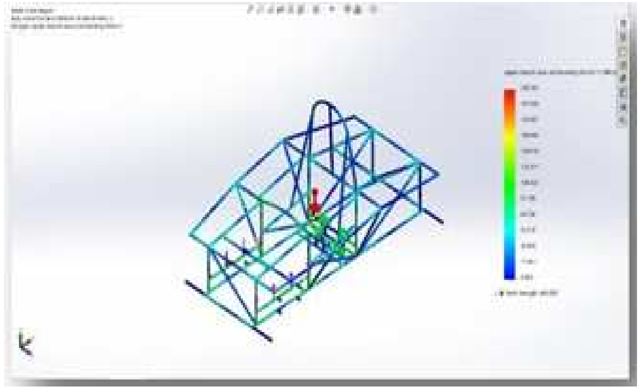


(b)

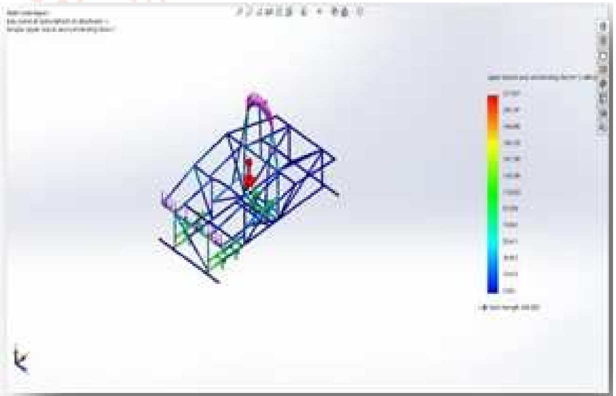


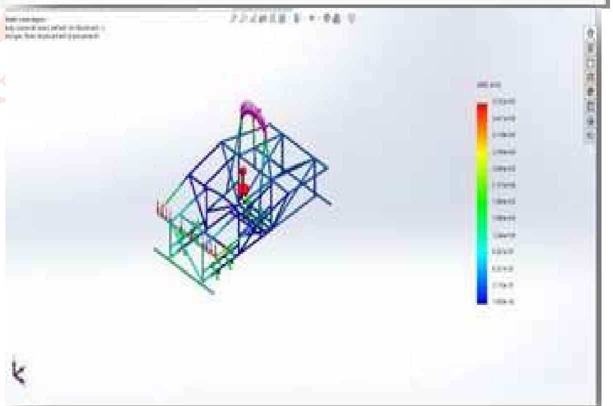
(c)

Fig 3: a,b,c represents the stress analysis of torsional test

5. Roll over analysis:-

mgh = (mv^2)/2
V = (2gh)$^{0.5}$ = (2 x 9.8 x 3)$^{0.5}$
W = mv^2/2 = (240 x 7.66^2)/2=7220 J
Frictional Force = μxmxg
=0.57x250x9.8
=1396.56 N≈1400N
Analysis of Roll over(FOS=3.3)





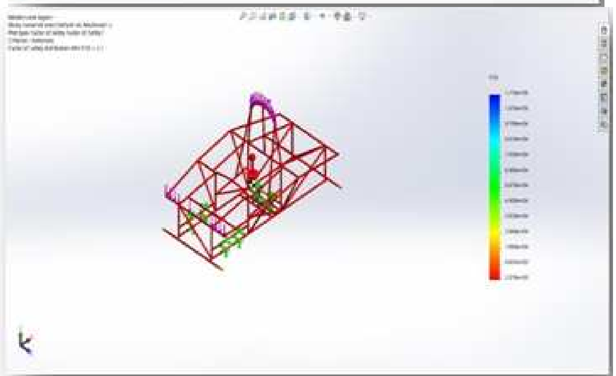
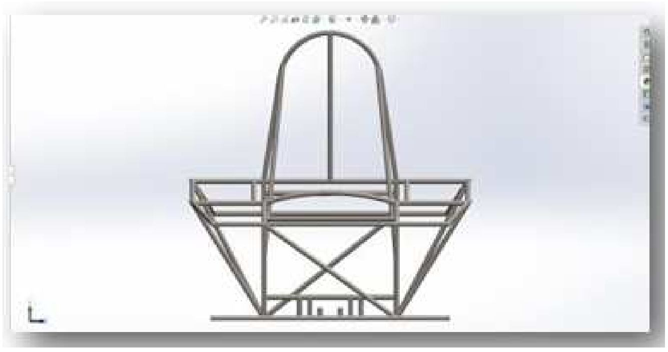


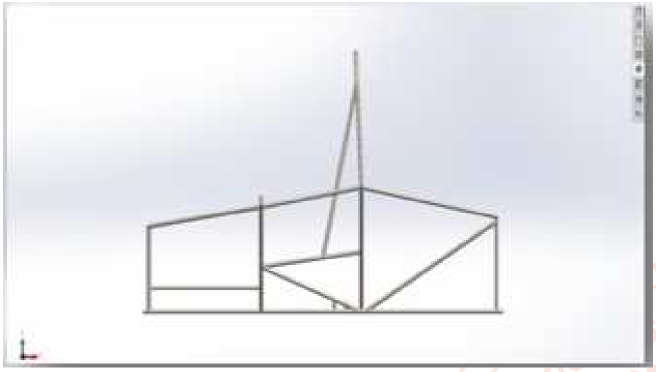
Fig4; represents the stress analysis on roll over test.

6. Roll cage Different views

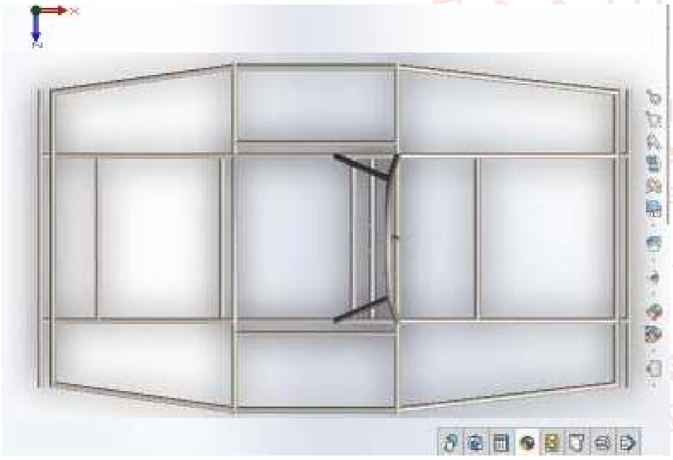
A. FRONT VIEW



B. SIDE VIEW



C. TOP VIEW



7. CONCLUSION

After performing calculation and simulations on the roll cage we found that the AISI 4130 is selected for manufacturing of roll cage for solar vehicle of dimensions (outer diameter 1inch and inner diameter 1.25inch and thickness of 1inch) it has less weight and better factor of safety .

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